

Pennsylvania Space Grant Consortium (PSGC)  
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Telephone Number: 814-865-8802  
Consortium URL: <http://pa.spacegrant.org>  
Grant Number: NNX10AK74H

## PROGRAM DESCRIPTION

The National Space Grant College and Fellowship Program consists of 52 state-based, university-led Space Grant Consortia in each of the 50 states plus the District of Columbia and the Commonwealth of Puerto Rico. Annually, each consortium receives funds to develop and implement student fellowships and scholarships programs; interdisciplinary space-related research infrastructure, education, and public service programs; and cooperative initiatives with industry, research laboratories, and state, local, and other governments. Space Grant operates at the intersection of NASA's interest as implemented by alignment with the Mission Directorates and the state's interests. Although it is primarily a higher education program, Space Grant programs encompass the entire length of the education pipeline, including elementary/secondary and informal education. The Pennsylvania Space Grant Consortium is a designated consortium funded at a level of \$575,000 for fiscal year 2012.

## PROGRAM GOALS

**PSGC Goals:** (1) Develop and promote opportunities for students to participate in research and discovery, including student flight projects; include programs with a focus on enhancing the participation of students from underrepresented groups. (2) Provide graduate and undergraduate training in NASA-related fields through the mechanism of fellowship and scholarship awards; increase the number of awards to students from underrepresented groups. (3) Support the development of interdisciplinary courses, curricula, and workshops, including introductory courses designed for undergraduate students not majoring in scientific or technological disciplines. (4) Model diversity in space grant leadership, programs, and activities; implement programs targeted at increasing the retention rate of students from underrepresented groups in science and engineering. (5) Provide information and programs to increase access to the excitement, knowledge, and technology from America's earth, air and space programs; establish PSGC as a viable state resource and catalyst for aerospace research, education, and economic development. (6) Cultivate a statewide network of partners from universities, industry, museums, science centers, state and local agencies to pursue aerospace research, education, and economic development goals. (7) Develop earth, air, and space programs to enhance public scientific literacy and to complement community needs.

**FY 2012 Targets:** Our target was to award 50 PSGC fellowships and scholarships. We intended to award ten statewide scholarships to support interns at NASA Centers. We planned to award 45 research scholarships to first-year, female, and minority

undergraduate students to gain hands-on laboratory experiences with an underlying objective of having 65% female and 30% underrepresented minority participation. We expected to support ten students in the Abington College Undergraduate Research Activities (ACURA) project, and ten for the National Radio Astronomy Observatory (NRAO) project at Penn State Abington. We expected to support five undergraduates at Franklin and Marshall College and Gettysburg College performing undergraduate research in the National Undergraduate Research Observatory (NURO) program. We aimed to have a total of 65 students participate in student space hardware programs (e.g. Student Space Programs Laboratory). We expected to have 20 student participants in the NASA-supported Penn State Flight Vehicle Design and Fabrication (FVDF) course. We aimed to support five West Chester University STEM majors in an undergraduate research program, and two HBCU students in our Lincoln University Environmental Sciences Research project. 13.8% of awards from each program were expected to be allocated to underrepresented minorities. We aimed to continue our mini-grant program by supporting four early career scientists and initializing two new higher education programs. Our goal was to have a total of 115 in-service educators participate in teacher professional development workshops (e.g. GLOBE). Through our precollege programs, we expected 25 high school and >75 middle school student participants. Finally, we aimed to support four PSGC community events.

## PROGRAM/PROJECT BENEFIT TO OUTCOME (1,2, & 3)

### PSGC Benefits to Outcome 1

*“Everything has been an overwhelmingly awesome experience! The hovercraft project was the first thing that I participated in here at Temple, it was also their first year doing it and it has been one of the funniest/challenging things I have ever done. In one class I learned so much about engineering. I was allowed to use my creative skills to create something that actually worked. It was beyond amazing. From this experience I wanted to do more and that’s why I started [C.R.A.T.E]. Participating in Vex this semester has only reinforced I and my team’s love for engineering.”* – Raven Hooper (founder), 2012 Competitive Robotics At Temple Engineering Club.

The Penn State Student Space Programs Laboratory’s CubeSat project was selected by NASA as one of 24 nanosatellites to fly an auxiliary payload planned for launch between 2014 and 2016. The team’s mission is to investigate space weather phenomena. The primary research goal of the satellite project is to characterize events in the heated ionosphere to create artificial weather. Results of the mission, beyond understanding radio-wave interaction with the ionosphere, can be used for research into space weather forecasting and for developing countermeasures to prevent damage to our infrastructure. Andre Coleman, a senior in aerospace engineering, serves as the thermal subsystem lead and states *“It is a learning opportunity for the next generation of great scientists and engineers. From working on this project, I have learned what personnel, expertise and effort are required for a significant aerospace engineering project to be successful.”* – Penn State 2012 SSPL Team.

### PSGC Benefits to Outcome 2

*“As a teacher candidate I was able to spend a tremendous amount of time this summer researching, planning the curriculum and teaching lesson plans to students in grades 4-6 and 7-8. Working with the NASTAR Education Programs has been a wonderful experience which I value dearly. Not only have I been able to get hands-on experience with students, I was also able to write curriculum and practice specific teaching techniques that I have been learning about during my undergraduate classes. I have been able to enter the classroom each day this summer with high expectations and new knowledge to share with students enrolled in the NASTAR Camp. The hands-on experience with STEM Education that the NASTAR Camp participants have had this summer has been unique and inspiring. The students are always enthused and full of questions and ideas revolving around the curriculum. Knowing that I have made some kind of impact on the students who participate in the summer program is what keeps me passionate about teaching.” – Jenna Loughlin, 2012 NASTAR Pre-service Educator Internship.*

## **PROGRAM ACCOMPLISHMENTS**

**Outcome 1:** *Fellowship/Scholarship, Higher Education and Research Infrastructure programs (Employ and Educate):*

In relation to our overall goals, we are proud to report that our college programming (F/S, HE, RI) totals 507 individual participants. This includes 174 participants in nine unique student hands-on engineering programs, and 199 awarded fellowships, scholarships and internships to students in STEM fields. Of the total awards, 80 were granted to underrepresented minority undergraduate and graduate students. Nine higher education and research infrastructure mini grants were awarded for faculty and research support. The PSGC mini-grant program is a competitive process available to faculty, researchers, post-doctoral fellows, and graduate students in an effort to build NASA competency in the areas of education and research. Additionally, PSGC developed one new course and revised seven pre-existing courses.

In terms of our specific targets for our fellowship and scholarship programs, we exceeded our goal and awarded 65 PSGC statewide fellowships and scholarships with 23% of awards granted to underrepresented minorities. We exceeded our undergraduate research scholarship target with 68 new WISER/MURE/FURP researchers and 50 returning scholars. Although the percentage of research scholarships awarded to underrepresented minority students increased from previous years, we did not meet the specific target of 30% minority participation; however, 91% of the scholarships were granted to underserved students in STEM (72% female and 19% minority, non-repeating). With 12 interns supported at NASA centers throughout the country, we surpassed our internship target. Our overall minority participation in fellowship and scholarship programming reached an impressive 21%, not only matching our state’s growing diversity population percentages, but exceeding it (based on the Pennsylvania State Data Center Census estimates).

In terms of our specific targets for our higher education programs, we exceeded our target with 36 students in the ACURA program, providing hands-on research and creative discovery for Penn State Abington undergraduate students that heighten interest in STEM

areas, resulting in 53% participation from underrepresented minority populations. Seven research papers authored by students and faculty mentors were submitted to conferences based on ACURA projects during 2012. Eleven ACURA students also participated in the NRAO project that consisted of a four day research trip to the National Radio Astronomy Observatory at the Green Bank Telescope. The NRAO project also attracted a diverse group of students with 73% underrepresented minority involvement, far exceeding our target of 13.8%. All of the students who participated in this program are intending to continue their majors in a STEM discipline. A student poster based on the NRAO project was presented at the Gordon Research conference on Physics Education Research. At Franklin and Marshall and Gettysburg colleges, NURO exceeded its targets with seven students involved in undergraduate research. Our student space hardware programs, including Penn State Students Systems Laboratory, Penn State University Student Launch Initiative, Temple University Student Space Exploration and Embedded Systems Laboratory, and Drexel University Space Systems Laboratory, greatly exceeded the overall student involvement targets with a total of 138 participants. Attracting female student involvement in these hands-on engineering programs remains to be a challenge. The FVDF course exceeded its participant target with 25 enrolled students, with 16% involvement from underrepresented student populations. Lastly, two new higher education programs were initiated in the fiscal year, meeting our mini-grant target. PSGC funded the Bryn Mawr Student Microgravity Research Team that had recently won a competition to conduct research onboard a NASA-flown Boeing 727-200 that simulates microgravity conditions. The student team was engaged in authentic NASA mission-based independent research projects and developed an online interactive lesson for undergraduates as part of their outreach plan. PSGC also funded a Gannon University High Altitude Radiation Detector program comprised of two student-centered projects, 1) High Altitude Student Platform payload design and 2) Gannon high-altitude weather ballooning system. To stimulate STEM interest and proactively recruit and place early-stage undergraduate students in the pipeline, scholarships were integrated into the overall management of this mini-grant program.

In terms of our specific metrics for our research infrastructure programs, we exceeded our targets for our West Chester University program with 10 STEM students involved in undergraduate research, particularly in the fields of Geology & Astronomy and Physics. This program places high emphasis on increasing the number of women in these departments with the goal of women in STEM continuing into graduate programs. Our Lincoln University Environmental Sciences project surpassed its target and awarded four scholarships to underrepresented minority students, three of which were granted to female participants. Our mini-grant program did not support early career scientists, but seven research infrastructure grants were awarded to faculty, post-doctoral, and graduate student researchers. Grant funding was in support of innovative research projects including the Hopper Spacecraft Simulator at Lehigh University, high-altitude ballooning at Penn State – Wilkes-Barre, and multiple projects at Penn State – University Park including Arctic plant study for climate warming research, Robot Snowmobile for glaciological work, Columbian Volcanic Lake Explorer for astrobiology study, and a Simulation Smackdown Competition for aeronautic robotic design.

**Outcome 2:** *Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers, and faculty:*

Precollege programming supported a total of 214 in-service educators. With regards to our specific targets, we exceeded our objectives for Penn State Science Workshops for Educators and Pittsburgh University GLOBE workshops with 157 enrolled in-service teachers. Nearly half of all participating teachers served classrooms with >50% underrepresented populations, including underprivileged rural counties in Pennsylvania, and 91% of teachers reported using the course content after one year. Susquehanna University's Saturday Science program met its workshop target by holding 12 meetings in the fiscal year, and exceeded its participant targets with 73 K-12 student participants, 56 parents involved, and 53 pre-service teacher participants. The Saturday Science program trains pre-service teachers in STEM areas as they prepare for careers in education, using program resources in Susquehanna University classes. The Temple University Introduction to Electrical Engineering course did not meet its student target with 17 high school participants; however, the program continues to be an excellent project for pre-college diversity with 47% female and 23% minority participation.

**Outcome 3:** *Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission:*

The PSGC exceeded its targets for Outcome (3) by funding five community events. Events included annual family science exhibitions at local elementary and middle schools, and activities related to topical events such as the Mars Curiosity Rover landing and the Falcon Telescope Network node at Penn State. In addition, higher education programs, including the Lehigh Hopper and Penn State FVDF course, include outreach components to their projects. For example, the Hopper Spacecraft Simulator is used as a STEM demonstration at several local middle and high schools to engage and inspire young students in NASA-related endeavors. Furthermore, PSGC supported a mini-grant project focused on research and learning in informal environments. A graduate student in Science Education designed an interactive program for families and groups at the Discovery Space Museum of Central PA. The museum exhibit incorporates a dynamic set of hands-on activities that provides an informal education experience for students and parents from the general public. This project is an example of the PSGC's effort to strengthen collaborations and build partnerships between the areas of education and science research, while incorporating elements of informal learning.

## **PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE MEASURES**

- **Student Data and Longitudinal Tracking:**

Total awards = 479; Fellowship/Scholarship = 199, Higher Education/Research Infrastructure = 280; 41 of the total award represent underrepresented minority F/S funding. During the FY12 program year 26 students are pursuing advanced degrees in STEM disciplines, 1 is seeking a STEM position, 8 accepted STEM positions at NASA contractors, 5 accepted positions at NASA, 39 accepted STEM positions in industry, 1

accepted a STEM position in K-12 academia, 13 accepted STEM positions in academia, and 35 went on to positions in non-STEM disciplines. The remaining students have not yet received the degree that they were pursuing while they received their Space Grant award.

- **Minority-Serving Institution Collaborations:**

Cheyney University of Pennsylvania is the oldest of the Historically Black Colleges and Universities in America. The mission of Cheyney University is to provide a higher education option to students of lower income and of African American heritage. The university specifically targets these students when advertising all academic programs including fields of significance to NASA and PSGC. One Cheyney University student was awarded an undergraduate fellowship for her work in the Aquaculture Research and Education Laboratory. This project gave the student the opportunity to not only conduct research at Cheyney but also interact with scientists and professionals out of her home institution.

Lincoln University, another HBCU, is nationally recognized for African American undergraduate students receiving degrees in the physical sciences, computer sciences, biological and life sciences. Most of the students (95%) in the School of Natural Sciences and Mathematics are minority, and over 65% of these students are female. The Lincoln University Space Grant project includes scholarships for environmental related research and provides students with the opportunity to present their research at STEM conferences. In FY 2012, PSGC supported four minority Lincoln University students, three of which are female, for the research scholarship program. One student received the NOAA fellowship and will continue conducting research in the summer of 2013 at an NOAA related facility.

- **NASA Education Priorities:** PSGC programming efforts serve all NASA Education current areas of emphasis.

- *Authentic, hands-on student experiences in science and engineering disciplines:*

With several projects dedicated to undergraduate research and space hardware development, we supported 450 undergraduate and graduate students in authentic, hands-on experiences in science and engineering disciplines. Examples of these programs include Gettysburg and Franklin & Marshall Colleges' National Undergraduate Research Observatory, where students conduct field work in astronomy, answering real research questions by actively observing, processing data, and conducting analysis, with the goals of recruitment and retention of physics majors and cultivating interest in STEM-related fields post-graduation.

- *Diversity of institutions, faculty, and student participants:*

PSGC strives to reach out to, welcome, and include the broadest range of students possible in all of our programming. Recruitment emphasis is placed on underserved and underrepresented populations within STEM disciplines. Many of our affiliate institutions have an extremely diverse student body, and awards are advertised to target underrepresented groups including, Women in Science & Engineering and the National Society of Black Engineers. Additionally, several initiatives are in place to advance these

diversity efforts, such as collaborations with community colleges throughout the state, outreach events focused on increasing underserved and underrepresented student involvement in STEM-related fields, and free science enrichment programs to low-income families. Internal PSGC programming focuses primarily on recruitment and retention of underrepresented students by offering research internships with high award emphasis on early-college-level women and minority undergraduates in STEM. Such diversity efforts resulted in a total of 239 women and 88 underrepresented minorities involved in college-level programs consortium-wide, totaling a combined percentage of 52% underserved higher education participation in FY 2012. Underserved students receiving direct monetary awards totaled 74%.

➤ *Engage middle school teachers in hands-on curriculum enhancement capabilities through exposure to NASA scientific and technical expertise:*

Programming that engages middle school teachers in hands-on curriculum enhancement continued in FY 2012. PSGC funded eight STEM workshops targeted toward middle school educators. In addition, higher education projects such as the Penn State University Student Launch Initiative and the Drexel Space Systems Laboratory incorporated outreach events into their engineering tasks where university students presented material related to rockets and science to middle school audiences, encouraging young students to consider engineering careers and providing teachers with information to take back to their classrooms.

➤ *Summer opportunities for secondary students on college campuses with the objective of increased enrollment in STEM disciplines or interest in STEM careers:*

Temple University's program in electrical engineering is a summer opportunity for high school students to participate in a five-week course in Electrical and Computer Engineering. The goals of this program are to encourage secondary school students to enter the higher educational system, and to introduce students to the field and profession of engineering. PSGC supported 17 high schools students at Temple University in this program during FY 2012, with 24% student participation from underrepresented minority groups. Students designed small programmable autonomous robots and were engaged in activities such as laser tag and maze mapping. The Penn State Student Space Systems Laboratory is also actively involved with secondary student opportunities. The lab hosted 30 high school students to talk about space systems and engaged the students in a hands-on soldering demonstration and discussion of general Electrical Engineering topics.

➤ *Community Colleges – develop new relationships as well as sustain and strengthen existing institutional relationships with community colleges:*

Community college partnerships continued to develop in FY 2012. The Lehigh University Undergraduate Research and NASA Explorer Schools project supported four community college students involved in research with Lehigh faculty. A greater number of community college students are exposed to research with university faculty than in years past. Community college collaboration and partnerships at Lehigh University will expand in the coming years. PSGC is also collaborating with Owen Software to provide

students at Harrisburg Area Community College software to help them explore STEM academic and career pathways.

- *Aeronautics research – research in traditional aeronautics disciplines; research in areas that are appropriate to NASA's unique capabilities:*

Many PSGC programs are committed to aeronautics research in suit with NASA's unique capabilities. One project example is research conducted at the Drexel Space Systems Laboratory. All Drexel Space Lab projects involve researching existing technology for the development of the students' final designs. The projects are particularly more intensive in the case of the morphing airfoil as this topic is still under investigation and research. Another example is the Lehigh Hopper project that uses the spacecraft simulator as a testbed for future student instruction and basic research in spacecraft dynamics.

- *Environmental Science and Global Climate Change – research and activities to better understand Earth's environments:*

Research and activity projects with an emphasis on environmental science and global climate change are in place at Drexel, Lincoln, Penn State, Susquehanna, and Temple universities. Lincoln University is designed to increase the number of minority students entering graduate school and enhance Lincoln's Environmental Science program. In order to promote research, PA Space Grant offered four student scholarships in the 2012 academic year, which provided students the opportunity to present their research at STEM conferences. At Penn State, a mini grant project was supported to design and build an autonomously controlled snowmobile to aid researchers in glaciological work in an effort to better understand climate change. Additionally at Penn State, three educator workshops were supported by Space Grant through the Center for Science and the Schools that focused on environmental science topics such as wind energy, climate change, and sustainability. Susquehanna University's Science Experience program continued to develop as a new part of Saturday Science, instructed by a member of the Environmental Sciences faculty, to include special environmental research activities focused on global climate change for rural middle school students. Finally, both Temple and Drexel universities' involvement in RockSat-C included elements of environmental science research by measuring environmental contents of the upper atmosphere. The 2012 RockSat project involved sampling of the atmosphere at predetermined altitudes for carbon dioxide.

- *Enhance the capacity of institutions to support innovative research infrastructure activities to enable early career faculty to focus their research toward NASA priorities:*

PSGC support of the Drexel Space Systems Laboratory is helping to cultivate future leaders in space technology by providing support for innovative space systems engineering research. Additionally, activities at Penn State, including the Flight Vehicle Design and Fabrication course, aim to support early career faculty in NASA-related priorities and aeronautical research.



## IMPROVEMENTS MADE IN THE PAST YEAR

In FY 2012, PSGC continued its effort to engage active and continuous involvement of all affiliate institutions. These efforts resulted in an enhanced management structure of effective reporting and successful programmatic outcomes in alignment with OEPM reporting procedures. The lead institution maintains strong focus on National Space Grant goals and objectives, and ensures impacts are aligned with NASA's Strategic Plan and the needs of Pennsylvania. Many new projects were developed in the past year with our expanded mini grant support in the areas of higher education, research infrastructure, and pre-college, with an emphasis on education and research. An increased effort was placed on diversity measures consortium-wide, and, in general, PSGC programs experienced greater participation numbers from women and underrepresented minority groups.

## PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

**Higher Education Institutions Receiving Funding (4-year):** *Lead Institution:* The Pennsylvania State University; *Affiliate Institutions:* California University of Pennsylvania, Carnegie Mellon University, Cheyney University (HBCU), Drexel University, Franklin & Marshall College, Gettysburg College, Lehigh University, Lincoln University (HBCU), The Pennsylvania State University – Abington, Susquehanna University, Temple University, University of Pittsburgh, University of Pittsburgh ERC, West Chester University; *Mini-Grant Recipients:* Bryn Mawr College, Gannon University, Howard University, The Pennsylvania State University Applied Research Laboratory, The Pennsylvania State University – Wilkes-Barre.

**Higher Education Institutions Not Receiving Funding:** *STEM Education Network Partners:* Duquesne University, Louisiana State University HASP Program Office.

**Government Institutions (Federal, State, Local):** *Teacher Professional Development Workshop Partners:* Aerospace Education Services Project, NASA Astrobiology Institute, NASA Goddard Space Flight Center, NASA Swift Mission, National Science Foundation, Pennsylvania Department of Education – Office of Environment & Ecology; *Higher Education Partners:* Microgravity University, NASA Ames Research Center, NASA Columbia Scientific Balloon Facility, NASA Glenn Research Center, NASA Goddard Space Flight Center, NASA Jet Propulsion Laboratory, NASA Kennedy Space Center, NASA Langley Research Center, NASA LARSS, NASA Marshall Space Flight Center, NASA Wallops Island Flight Facility, NOAA National Weather Service.

**Industry:** *Affiliate:* NASTAR Center; *Corporate Partner Funding Source:* Boeing Corporation, National Radio Astronomy Observatory.

**Other Non-Profit Organizations:** *STEM Education Network Members:* Academic STEM Alliance (Bald Eagle, Bellefonte, Penns Valley School Districts), Allentown School District, Audubon Society of Western Pennsylvania – Beechwood Farms Nature Preserve, Bethlehem School District, Center for Science and the Schools, National Alliance of State Science and Math Coalitions, Pennsylvania School for the Deaf, Selinsgrove Area School District, Solar System Ambassadors, Pennsylvania STEM Initiative, Philadelphia School District.

**Other Organizations:** *STEM Public Outreach Partners:* The Carnegie Science Center, The Discovery Space of Central Pennsylvania, The Franklin Institute, Penn State Public

Broadcasting; *Community/Local*: Air & Waste Management Association, Diocese of Pittsburgh, Howard Hughes Medical Institute, Washington County Department of Public Safety; *Higher Education Partners*: Colorado Space Grant Consortium.

**The National Space Grant Office requires two annual reports, this Annual Performance Data Report (APD) and the Office of Education Performance Measurement System (OEPM) report. The former is primarily narrative and the latter data intensive. Because the reporting timeline cycles are different, data in the two reports may not necessarily agree at the time of report submission. OEPM data are used for official reporting.**